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How To Tune The Power Valve In A Holley Carburetor

Even the name “power valve” sounds impressive. There’s a power valve in every Holley four-barrel carburetor and we’re going to show you how it can offer improvements in throttle response and even potentially save a little fuel for the guys who plan on lots of highway and street miles.

Let’s start by making sure everybody knows why there’s a power valve circuit and how it works. In every Holley two- and four-barrel carburetor, the power valve is located primarily in the primary metering block, though there are models that have a power valve in the secondary metering block. The purpose of the power valve is to improve part-throttle drivability, air-fuel ratio, and fuel mileage.

The Holley power valve is a simple diaphragm with a tapered seat-valve that is exposed on the carb body side to intake manifold vacuum. With high manifold vacuum in a part-throttle situation, this low pressure “pulls” on the valve keeping it closed. As the throttle opens and the load increases, the manifold vacuum will drop. At a calibrated point, a spring inside the power valve will overcome the low manifold vacuum and open the valve.

When the power valve opens, it directs fuel from the float bowl into the main well in the metering block. The main well is the circuit that directs fuel into the primary boosters in the venturi of the carburetor. This power enrichment circuit is completely separate from fuel delivered by the main jets and is used to supplement the amount of fuel supplied by the primary jets.

This might trigger a question as to why an additional circuit is necessary. Why not just increase the jet size and eliminate this circuit? That’s an excellent question and the Holley carburetor designers offer an equally elegant answer. Even on a race engine, there are times when the engine will operate at a light throttle such as driving through the pits at a drag race. The power valve circuit delivers a rather substantial amount of additional fuel when at near wide-open-throttle (WOT). By reducing the primary jetting at part-throttle, the engine operates at a leaner air-fuel ratio which prevents fouling plugs and washing the cylinder walls with excess fuel, which can damage piston rings.

This is especially important for street engines because these engines operate over 80 percent of the time at light throttle opening. Generally, the power valve circuit will introduce the rough equivalent of 6 to 8 jet sizes worth of additional fuel. This reduces the primary jet size by that same amount. As an example, a 750 cfm mechanical secondary (PN 0-4779-10) employs a 71 primary jet combined with a power valve. The secondary side does not use a power valve but is fitted with an 80 rear jet that is 9-steps larger. The increase in secondary jetting compensates for the absence of a secondary power valve with an equal amount of fuel delivered from both the primary and secondary sides of the carburetor at WOT.

All Holley power valves are stamped on the side or, as in this case, the metal reinforcement near the center. You can see an "8" and a "5" making this an 8.5"Hg power valve. The stamps on the top are date codes. The range for standard Holley valves is from 2.5 to 10.5 "Hg (inches of Mercury).

Each power valve is rated to open at a given manifold vacuum level and Holley offers a wide range of these opening values. Intake manifold vacuum for carbureted engines is generally expressed in inches of mercury, or "Hg.

For example, the most commonly used Holley power valve is rated at 6.5 "Hg, which means the valve will open when manifold vacuum drops to 6.5 "Hg or lower. Idle vacuum on street engines can be anywhere from 9.0 "Hg for engines with radical, lumpy camshafts and a rough idle. Stock engines typically idle smoothly at 14 to 16 "Hg.

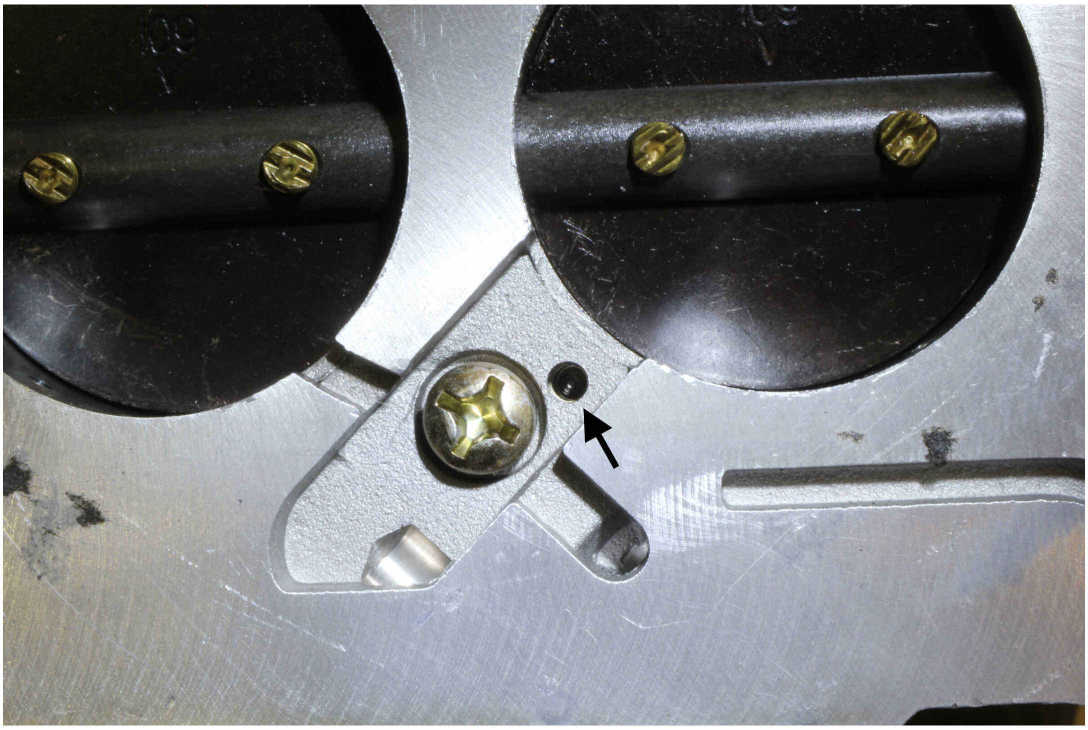
So now that we know how the power valve circuit operates, let's look at how we can use this information to help tune a particular engine combination for the street. It's also important to note that a Holley carburetor's out-of-the-box tune for a typical mild street engine will often be very close. A typical 3310-9 750 vacuum secondary Holley on a 355ci small-block Chevy with a mild cam, good heads, intake, and headers will likely be very close to what the engine wants. But having stated this, hot rodders are inveterate tuners and may want to see if they can make their engine run even better.

We can start with some basic tuning recommendations. For a street car with an automatic transmission, use your vacuum gauge to read the idle vacuum of a fully warm engine at idle in gear. Let's put this idle vacuum at 13 "Hg. If we divide the idle vacuum in half, this results in a 6.5 "Hg power as a great starting place for tuning.

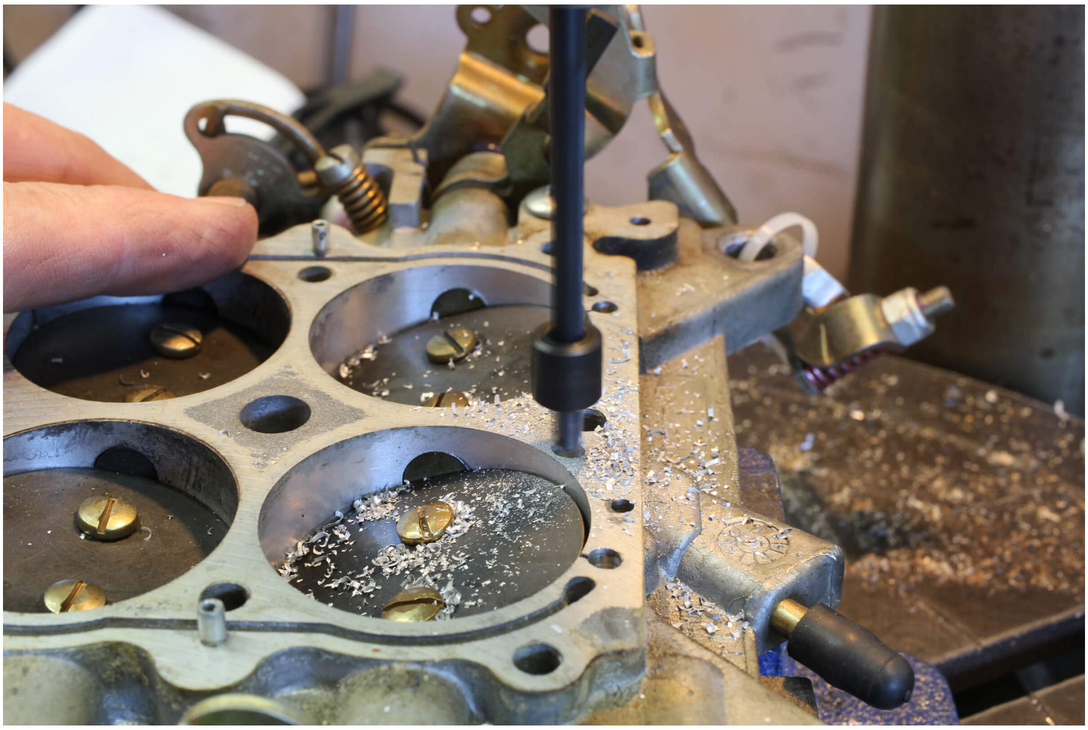
This will open the power valve when the manifold vacuum reaches 6.5 "Hg or lower. Some tuners prefer to open the power valve a little earlier to prevent the engine from running lean at heavier part-throttle that could cause detonation problems. In this case, the tuner might raise the power valve closer to 8.5 or perhaps 9.0 "Hg.

You can find plenty of discussion regarding a power valve that will or will not open at idle. The idea behind having a power valve that is open at idle is that the the idle and power enrichment circuits are separate and therefore, there will be no effect. While the idle and main circuits are separate, an over-rich main circuit at idle will have an effect on idle quality. The power valve needs to remain closed at idle.

This urban myth has probably survived because of issues with older Holley carburetors that occasionally suffered from a damaged power valve. If the power valve diaphragm fails or leaks, it will allow fuel to enter the intake manifold through the carburetor base plate.



It’s difficult to see, but there is a small check-ball (arrow) in this channel that directs manifold vacuum to the power valve cavity in the metering block. This check valve prevents damage to the power valve in case of an engine backfire. This is standard on all Holley carbs built beginning in 1992.



Holley carburetors built before 1992 can be easily converted to a power valve check-ball to protect against backfire damage. The Holley kit comes with a drill bit, check-ball, a tiny tapered spring, and press-in washer to retain the assembly. The check-ball is placed into the manifold vacuum passage in the throttle plate.

Holley addressed this issue beginning in 1992 by incorporating an anti-backfire check ball into all its carburetors. This prevents damage to the power valve in the case of an engine backfire. It's also easy to retro-fit an early Holley carburetor with a Power Valve Check Ball kit. We've done this conversion several times. It is very easy to accomplish and takes perhaps a half-hour to perform.

Getting back to power valve tuning, let's assume that we have installed a Holley air-fuel ratio (AFR) meter on board to help us measure the results of combustion. A wide-band oxygen sensor can be very helpful with tuning. Let's assume that our engine is running at a steady-state cruise on level ground on the highway at around a 13.1:1 air-fuel ratio with an engine vacuum reading of 14 "Hg of manifold vacuum.

We'd prefer to have this engine run slightly leaner at part throttle. Some enthusiasts are afraid that a lean engine will run hot, but this is not the case at light load. Let's theoretically put our primary jet size at a 72. If we decide to switch to a leaner 69 jet. For the sake of this discussion let's say this improves our part-throttle cruise AFR from 13.1:1 to 13.6:1. This represents a leaner AFR and the engine seems to run nicely so we'll make this a permanent change.

However, this has also reduced the total amount of fuel delivered to the engine. Let's say that now our WOT AFR has shifted from 12.6:1 to a leaner 13.0:1 which is probably a touch lean. We could just add 3 jets sizes to the secondary side of the carburetor. However, this upsets the balance of fuel delivered into the engine in a fore-aft relationship and could potentially contribute to the front cylinders running lean. You may have guessed that there's a simple way to solve this issue.

The power valve circuit uses a dedicated restrictor that determines the amount of fuel delivered when the power valve opens. Holley calls this a power valve circuit restrictor (PVCR). There are two of these restrictors located underneath the power valve. The PVCR is sized differently depending upon carburetor metering requirements. For example, a 670 cfm Holley Avenger carb uses a 0.042-inch PVCR while a larger 750 HP carb will be sized closer to 0.050-inch.

Let's use the 750 HP Holley to see how we can resize the PVCR. This will require some simple math. Trust us, it's not difficult. The first item we need to know is the drill size of the primary jets. In the case of our 750 example, a 72 jet uses a 0.079-inch diameter (see Jet Chart). We can calculate the area of this orifice with the formula π x radius x radius (Pi r squared). If we subtract the diameter of the 69 jet from the 72 jet this will give us the area we have to increase the PVCR.

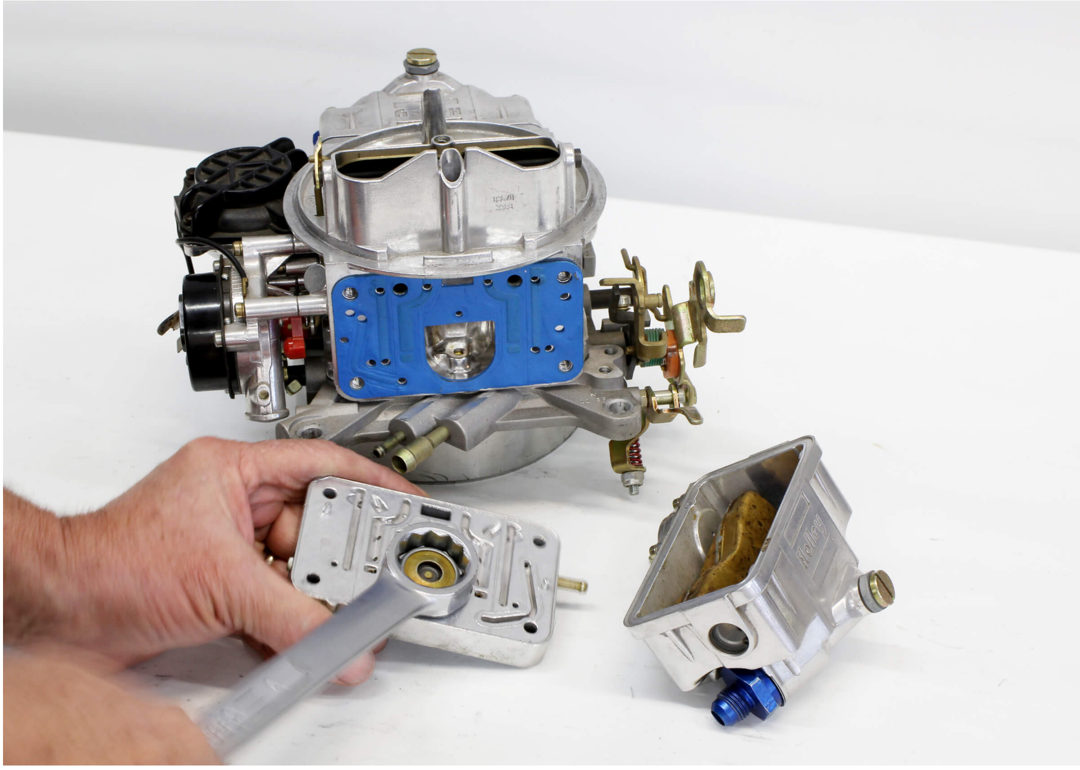
We'll save you the grief of the math, but the jet change produced a jet area increase of 25 percent. So we multiplied the area of the 0.052-inch PVCR and then discovered that a PVCR diameter of 0.058-inch (0.006-inch larger) would increase the flow area roughly equal to how much we reduced the jet size.

This will require a small, specific sized drill bit. But there are other ways to do this. Several Holley carbs like the Ultra HP come with screw-in bleeds in place of fixed restrictors for the PVCR. Quick Fuel Technology also sells a billet aluminum metering block with screw-in 6-32 size bleeds that make these changes much easier. Holley also sells these bleeds either in a kit or 4-packs.

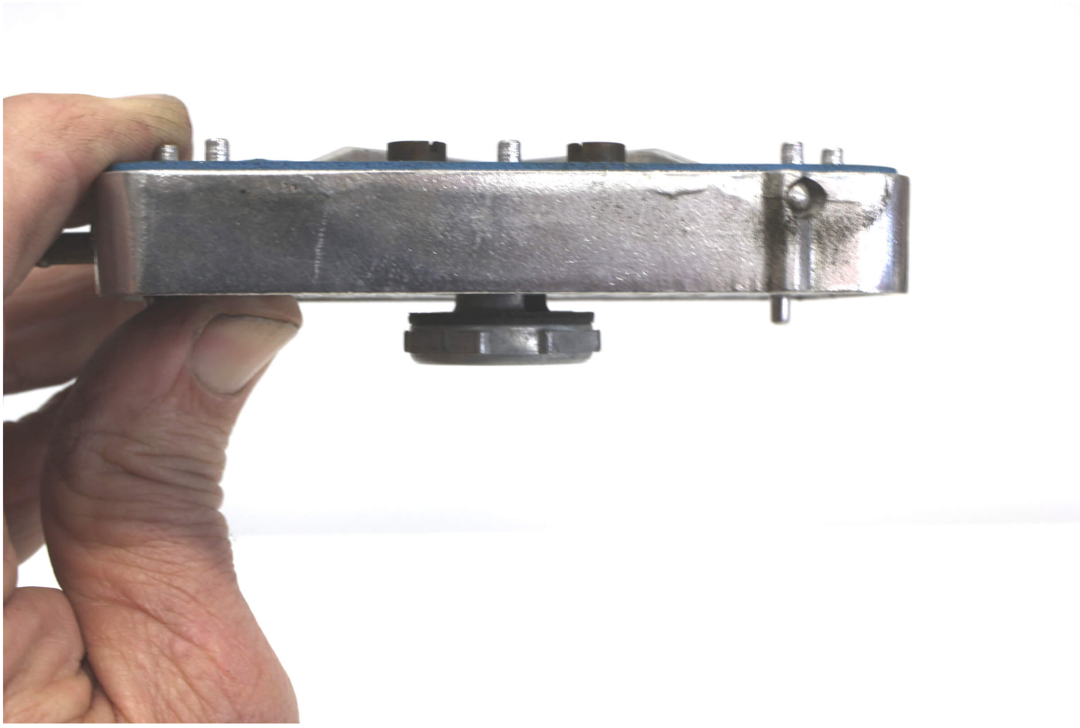
We'll admit that this might seem like a lot of work for a very small change, but let's dig a little deeper. We hear all the time about how EFI is so much better than a carburetor because EFI can manage air-fuel ratios at part throttle on a much tighter level than a carburetor. While instant feedback EFI does offer advantages, the power valve tuning session we just outlined between the primary main jets and the PVCR is exactly how you narrow down that margin between EFI and a well-prepared street carburetor. There are many possible equations for AFR tuning that are based upon the vehicle's weight, engine, gearing, and other factors that will come into play, but for a generalized understanding, use the following ranges as a good starting point to dial in your tuning:

- Cruise: 14.7:1 - 15.5:1
- Idle: 13.5 - 15.0
- Stoich: 14.7:1
- Wide-open throttle: 11.5:1 - 13.3:1

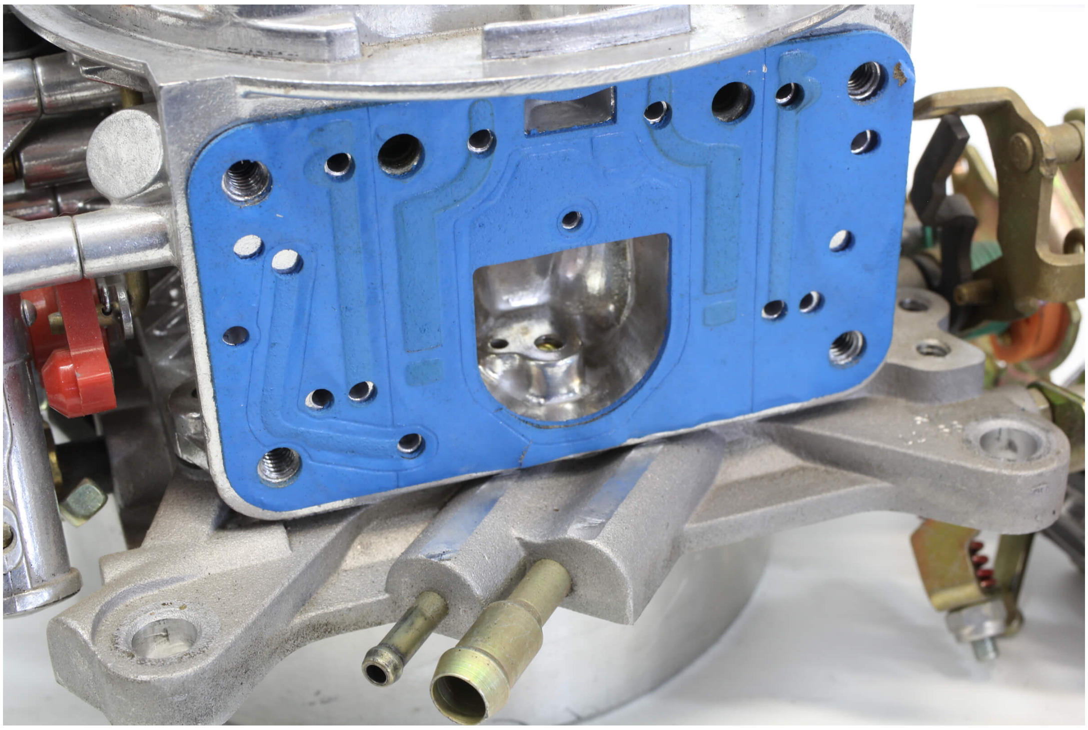
The advantage for the knowledgeable carb tuner is that he can perform these modifications on an affordable carburetor and get very close to the same part-throttle performance as the best EFI system. The more you know about how the power enrichment circuit works, the better tuner you will become.



Once the fuel bowl and metering block have been removed, it’s easy to change the power valve by using a 1-inch box end wrench to loosen and unscrew the valve from the metering block.

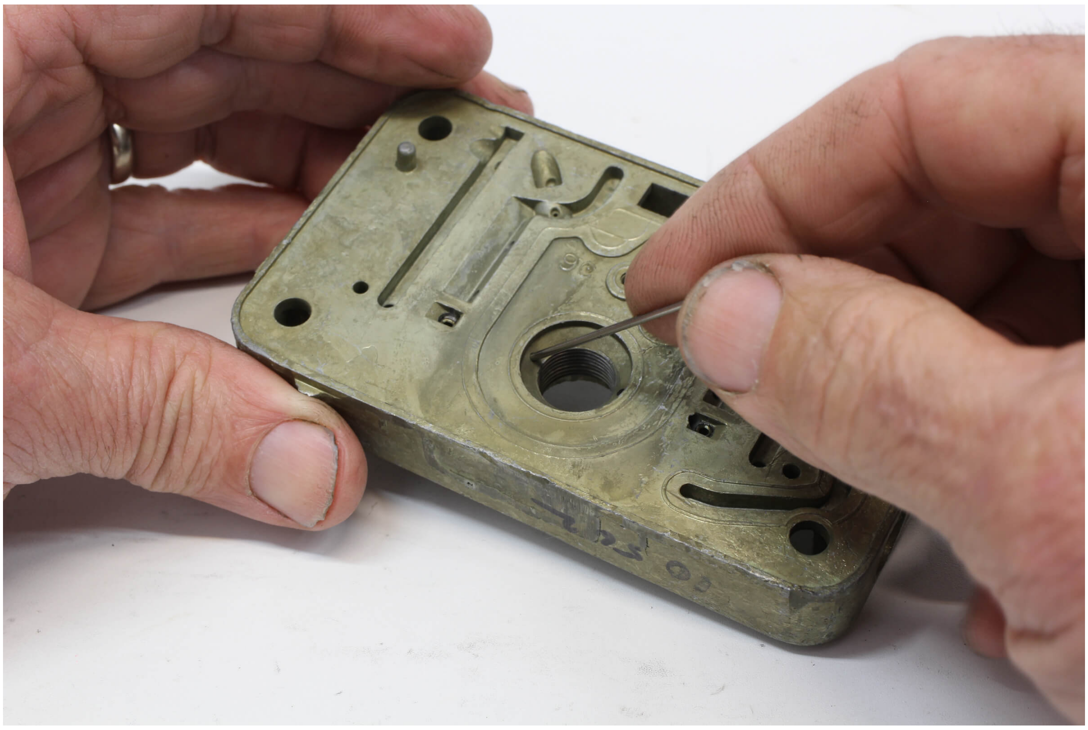


When installing the power valve in the metering block, we like to set the gasket on the power valve, invert the metering block, and thread the valve in place. This ensures the gasket remains properly centered on the power valve.

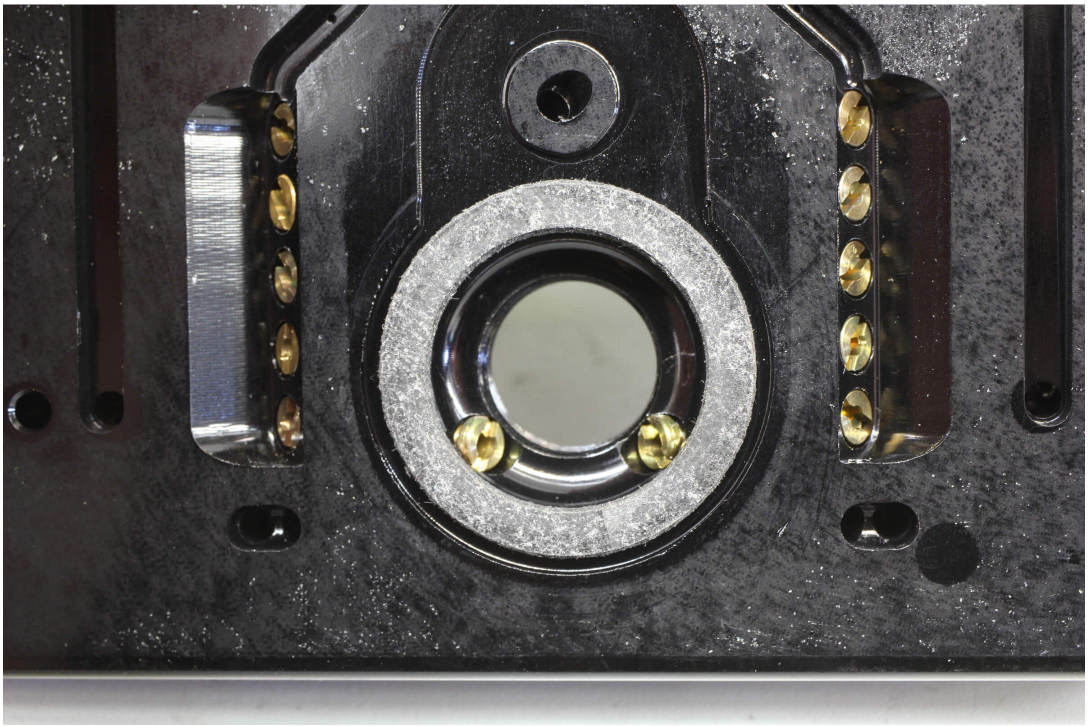


This cavity in the main carburetor body is sealed to the back side of the power valve. The only opening is through the small hole in the bottom of the cavity that connects to manifold vacuum. The large cavity ensures a balanced vacuum signal to the power valve.

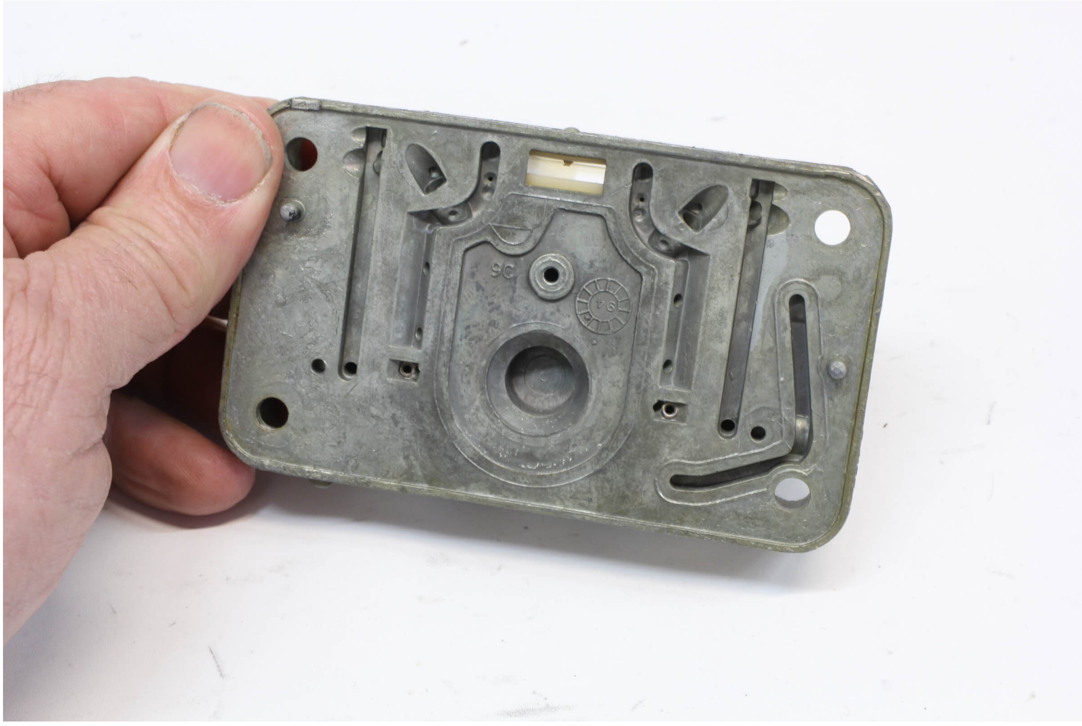
That small tapered seat behind the spring (arrow) is where the fuel enters the power valve from the float bowl. It exits through the windows and then enters the area where the PVCR are located.



With the power valve removed, you can see two small holes just outboard of the threaded hole. These two holes are the PVCR (power valve channel restrictions). We measured these with pin vices at 0.052-inch in diameter.



Newer performance Holley carbss like this Ultra HP come with screw-in PVCR that makes changes to these restrictors really easy. It’s also possible to upgrade your existing Holley with a Quick Fuel Technology billet aluminum metering block with these same screw-in bleeds.



Most secondary metering blocks do not have a provision for a power valve as the secondaries are rarely-to-never open at light loads or cruise.
